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None
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(54) Brush seal manufacture

(57) A brush seal is made by winding one or more wire filaments 18 on a flat annular or straight wax mandrel 10 having a metal bead 16 along one edge, placing a channel or hairpin section retaining element 20 over the edge bead, crimping the retaining element to clamp the filaments while simultaneously melting out the wax, the filaments being then severed, as at T—T, by grinding to form bristles anchored in the retaining element by the metal bead.

Fig.3.

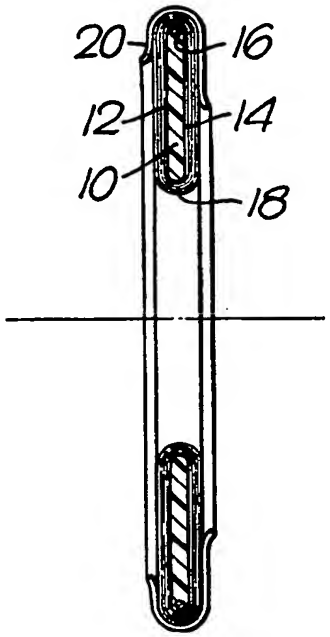
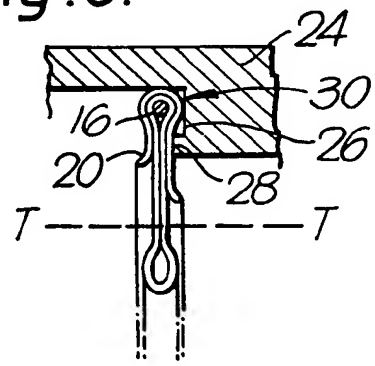


Fig.6.



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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Fig.1.

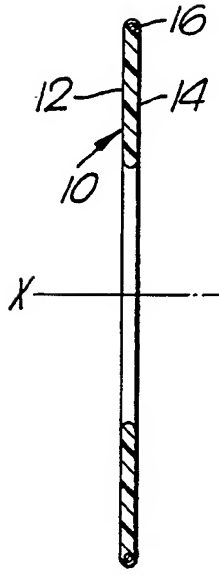


Fig.2.

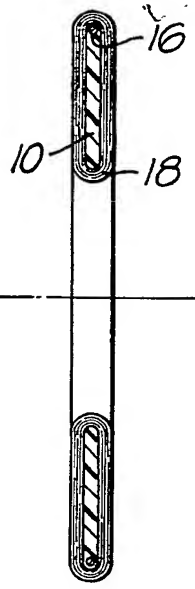


Fig.3.

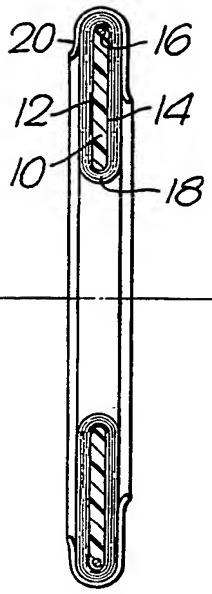


Fig.4.

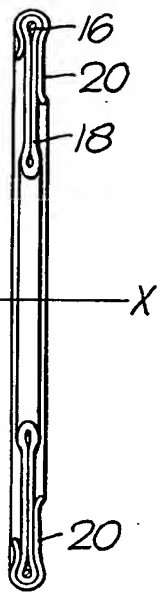


Fig.5.

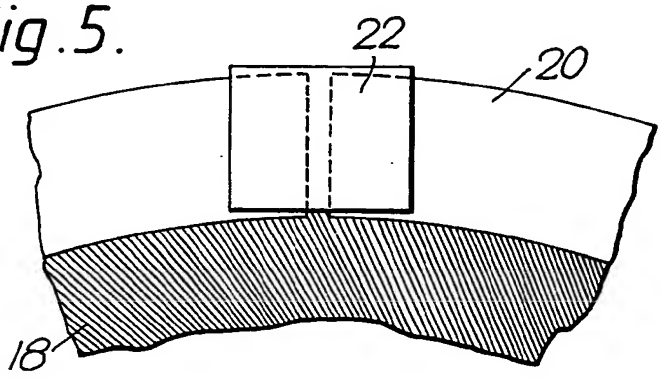


Fig.6.

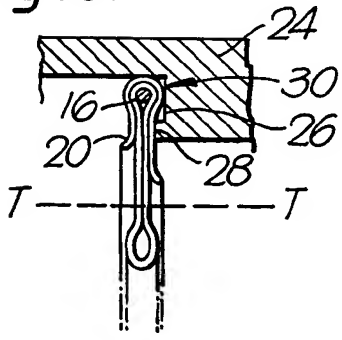


Fig.7.

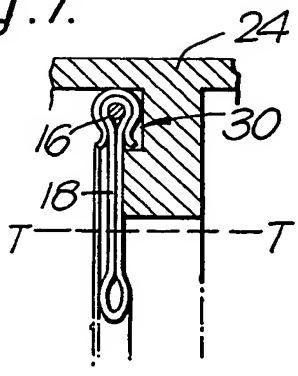
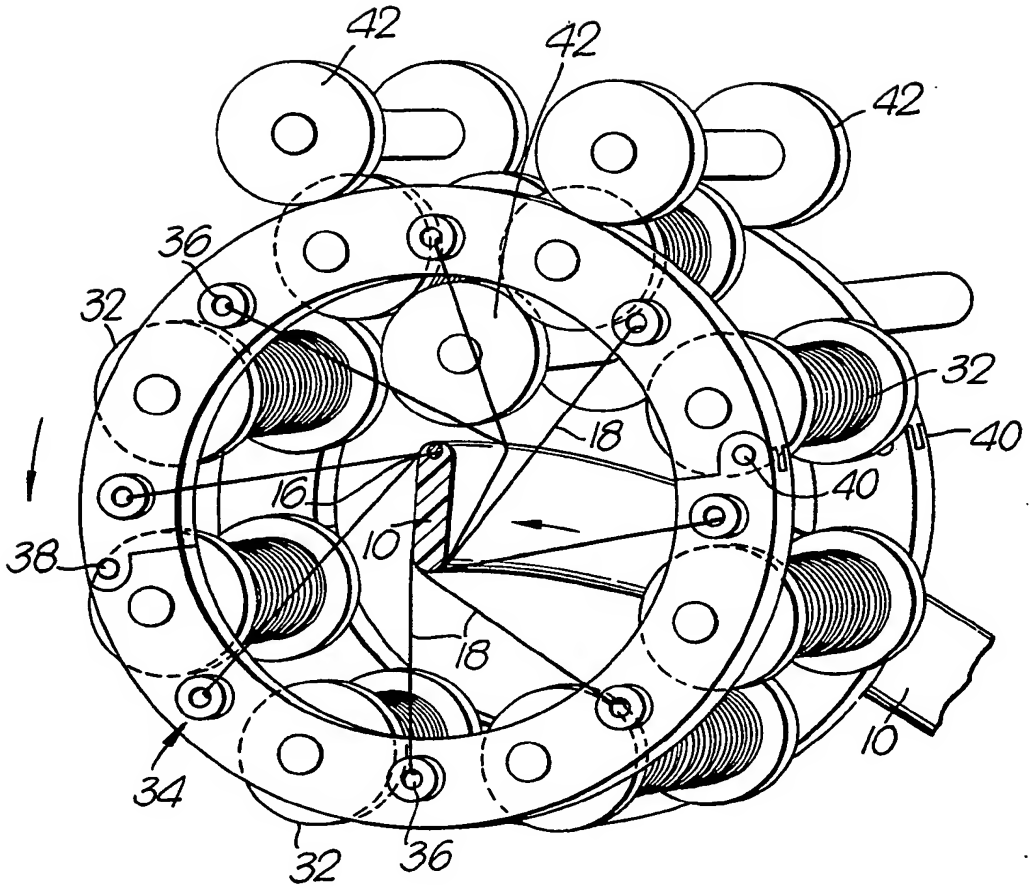


Fig.8.



SPECIFICATION

Brush seal manufacture

This invention relates to the manufacture of brushes, and specifically, but not exclusively, the manufacture of brush type seals for use in forming effective air seals with rotating surfaces, for example the surface of a turbine shaft in a gas turbine engine.

It is known from our U.K. Patent No. 1450553 to manufacture a brush seal by sandwiching between a pair of side plates a number of brush bristles which project freely from one or the other of the edges of the side plates, the bristles being bonded to the side plates by welding brazing or other means. A method of the manufacture of such brush seals has been described in our U.K. Patent Applications 28776/78 (Serial No. 2001400) whereby a continuous filament of bristle material is wound onto a side plate so that it lies across an exposed face of the plate and then a further side plate is superimposed on this exposed face to sandwich the bristle material between the two side plates, the bristle filaments being cut after bonding the bristle material to the pair of side plates.

The present invention seeks to provide a method of manufacturing a brush, for example a brush seal, by a winding method which is essentially simpler and cheaper than the previously used methods. The present invention accordingly provides a method of manufacturing a brush comprising the steps of winding at least one filament of bristle material around a flat mandrel of fusible material having opposite side faces and incorporating a metal bead along one edge, placing a channel section retaining element over the said edge of the mandrel in contact with the wound filament on the said side faces, crimping or deforming the retaining element and melting the mandrel material to clamp together portions of the wound filament around the bead to anchor the filaments, and severing the filaments to form a brush with bristles anchored by the retaining element.

By using a mandrel of fusible material, such as wax, effective anchoring of the bristle material can be achieved by the crimping or deforming of the channel section retaining element, the bristle material being effectively anchored by the metal bead trapped within the channel section retaining element after the crimping or deforming operation.

For the manufacture of an annular brush of the type used as a brush seal on, for example, a turbine shaft, the mandrel would comprise a flat annulus, For other applications, where a straight seal is required, the mandrel would be in the form of a rectilinear strip with flat opposite side faces.

The bristle filament may be wound around the mandrel at an angle, typically 45°, to the said edge of the mandrel. Winding of the filament may be effected by adapting suitable currently available winding machines, the filament material being chosen according to the intended use of the brush. For example, for use in a turbine seal for high temperature operation bristle filaments of nickel alloy such as that sold under the Trade name "NIMONIC 75" may be used. For other application, however, non-metallic bristle filaments may be employed, for example plastics or fibre reinforced plastics material, or carbon fibre bristle filament may be used for high temperature applications.

Where the resulting brush is to be used as a brush seal for withstanding air pressure in one direction the two walls of the channel section retaining element preferably have different depths, the severing of the filaments being effected beyond and parallel to the free edge of the retaining wall of greater depth.

The filaments are preferably severed by grinding or machining to a substantially equal depth after anchoring the filaments in the retaining element.

The invention will be further described, merely by way of example, with reference to the accompanying drawings, in which:

Figures 1 to 4 are diagrammatic diametral sectional views through a mandrel and associated retaining element used in the formation of a brush seal according to a method of the present invention, showing successive steps in the method;

Figure 5 is a fragmentary view of part of the mandrel and retaining element shown in Fig. 4, illustrating the step of interconnecting adjoining ends of the retaining element;

Figures 6 and 7 are diagrammatic partial sectional views in a diametral plane illustrating the final trimming stage in the formation of an annular brush seal by the method of the present invention, using two alternative retaining elements and supporting members, and

Figure 8 is a diagrammatic perspective view illustrating part of a machine for winding a filament upon a mandrel, for use in the process of the present invention.

The process of the invention, as illustrated in the drawings, forms an annular brush seal of the kind for use in making an effective seal with the surface of a turbine shaft. The process makes use of a thin annular mandrel 10 of hardened wax having opposite flat faces 12, 14 with a metal wire ring 16 embedded in a peripheral groove in the outer edge of the mandrel 10. The axis of the mandrel 10 is indicated diagrammatically by X–X in Figs. 1 to 4.

One or more filaments 18 of bristle material, for example nickel alloy wire, glass fibre reinforced plastics filaments, or carbon fibres, is or are wound around the mandrel 10 so as to enclose the mandrel and the bead wire 16 completely in a number of turns of

bristle filament 18, as shown in Figure 2. The bristle filaments may be wrapped around the edges of the flat mandrel 10 either in a generally radial direction or, preferably, at an angle of substantially 45° with the edges of the mandrel.

After winding the mandrel 10 a channel or "hairpin" section retaining element 20 with a curvature corresponding to that of the outer circumference of the annular mandrel 10, is slid around the outer periphery of the mandrel (Fig. 3) so as to overlie the wound filaments 18 on both faces 12, 14 of the mandrel. In the illustrated embodiment the two walls of the channel section retaining element 20 have different depths. After fitting the retaining element 20 in position the opposite walls of the retaining element are crimped together using a crimping tool (not shown) which is heated to a temperature such as to melt the wax of the mandrel 10. Consequently the wound filaments 18 are crimped together by the walls of the deformed retaining element (Fig. 4). The peripheral wire ring 16 is enclosed by the radially outer turns of the filaments 18 and is trapped within the deformed retaining element 20, acting as a bead and effectively anchoring the crimped filaments 18 in the retaining element 20.

The heated crimping tool used to deform the retaining element 20 and to melt the wax of the mandrel 10 also irons the bristle filaments flat between the opposite walls of the deformed retaining element.

Following the crimping and melting operation the abutting ends of the channel section retaining element 20 are covered by a sheet metal clip 22 (Fig. 5) which is bonded to the retaining element 20 by, for example, spot welding or adhesive.

The partially completed annular seal is now located in a supporting member 24, part of which is illustrated in Fig. 6, having a radial shoulder 26 terminating in an axially projecting lip 28 which defines with the shoulder 26 a shallow annular groove 30. One side of the crimped annular retaining element 20 is located in the groove 30 and the lip 28 provides axial support against the wall of the retaining element 20 of greater depth, this wall being located on the low pressure side of the annular brush seal in use.

In an alternative seal construction, illustrated diagrammatically in Figure 7, where the two walls of channel section retaining element 20 have equal depth, the annular lip 28 of the axial support element 24 would engage one axial face of the bunched filaments 18, the retaining element 20 being located entirely within the shallow groove 30.

After locating the partially completed annular seal in the support member 24 the looped radially inner ends of the filaments 18 are cut off in a trimming operation which may be performed by a trimming or grinding step, so that the inner ends of the severed filaments 18 lie on a common cylindrical surface with a diameter substantially equal to the diameter of the surface (for example, a turbine shaft) to be sealed. The surface along which trimming is effected is indicated diagrammatically by the line T—T in Figures 6 and 7. The machining of the filaments may be carried out by standard grinding techniques, for example using electro-discharge grinding.

The completed annular brush seal may be retained in its housing when fitted, for example, to a gas turbine, by means of a "circlip" (Registered Trade Mark) or other spring retaining means.

Fig. 8 illustrates diagrammatically part of a typical machine for winding multiple filaments 18 onto a flat annular mandrel 10 as described above with reference to Fig. 2. A number of filaments 18 are carried in respective spools 32 (eight in number in this example) mounted upon an annular spool carrier 34 which surrounds part of the circumference of the flat annular mandrel 10, the axis of rotation of the annular spool carrier 34 lying in the circumferential direction of the mandrel 10 perpendicular to the axis of rotation of the mandrel 10. The filaments 18 from the spools 32 pass through holes 36 in one axial face of the spool carrier 34 and are wound around the flat mandrel 10. The spool carrier 34 is formed in two symmetrical halves which are hinged at 38 and releasably latched together at 40 to enable the spool carrier 34 to be placed in position surrounding the periphery of the annular mandrel 10.

In use of the machine the annular mandrel 10 is driven by, for example, friction drive rollers (not shown) engaging the internal peripheral edge of the mandrel 10, and the spool carrier 34 is rotated about its axis by friction drive rollers 42 engaging its internal and external surfaces. The angle at which the filaments 18 are wrapped around the mandrel 10 will be determined by the relative speeds of rotation of the mandrel 10 and the spool carrier 34, these relative speeds being adjusted to achieve the desired winding angle.

The annular brush seal manufactured by the method described and illustrated is of the internal type, having radially inwardly projecting bristles for engagement with, for example, the cylindrical surface of a turbine shaft. The method of the invention is, of course, equally applicable to the manufacture of brush seals having radially outwardly projecting bristles, or rectilinear brush seals in which the bristles are supported in a straight retaining element.

CLAIMS

1. A method of manufacturing a brush comprising the steps of winding at least one filament of bristle material around a flat mandrel of fusible material having opposite side

faces and incorporating a metal bead along one edge, placing a channel section retaining element over the said edge of the mandrel in contact with the wound filament on the said side faces, crimping or deforming the retaining element and melting the mandrel material to clamp together portions of the wound filament around the bead to anchor the filaments, and severing the filaments to form a brush with bristles anchored by the retaining element.

2. A method as claimed in Claim 1, in which the mandrel comprises a flat annulus.

3. A method as claimed in Claim 1 or Claim 2, in which the filament is wound around the mandrel at an angle of 45° to the said edge of the mandrel.

4. A method as claimed in any one of Claims 1 to 3, in which the mandrel is made of wax, the filament being of metal wire.

5. A method as claimed in any one of Claims 1 to 4, in which the two walls of the channel section retaining element have different depths, the severing of the filaments being effected beyond and parallel to the free edge of retaining element wall of greater depth.

6. A method as claimed in any one of the preceding claims, in which the filaments are severed by grinding or machining to a substantially equal depth.

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